INTEGRATED CIRCUIT METAL-INSULATOR-METAL CAPACITORS INCLUDING HEMISPHERICAL GRAIN LUMPS

Abstract of the Disclosure

The effective area of a MIM capacitor is increased by forming a lower electrode that includes hemispherical grain lumps. The hemispherical grain lumps are formed by heat-treating a metal layer in an oxygen and/or nitrogen atmosphere, thus oxidizing the surface of the metal layer or growing the crystal grains of the metal layer. The MIM capacitor may be formed of Pt, Ru, Rh, Os, Ir, or Pd, and the hemispherical grain lumps may be formed of Pt, Ru, Rh, Os, Ir, or Pd. Since the metal layer is primarily heat-treated during the formation of the lower electrode, it is possible to reduce the degree to which the surface morphology of the lower electrode is rapidly changed due to a heat treatment subsequent to forming a dielectric layer and an upper electrode.